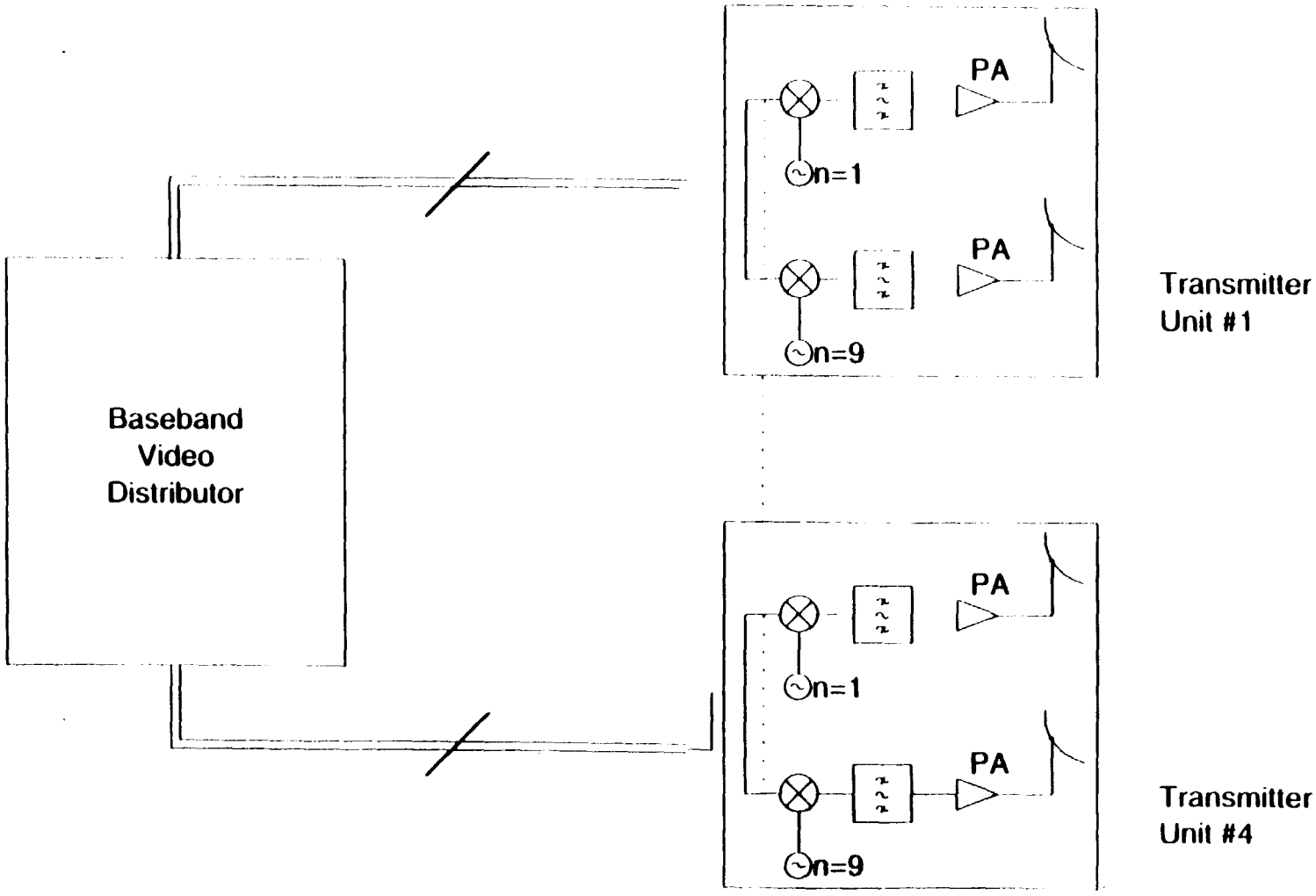
Current MVDS Equipment

- PHILIPS Transmitter Unit specification
  - 4 transmitter units, each with 8+1 (redundant) transceiver
  - Redundant transmitter on Hot Standby (200 MHz bandwidth)
  - Seperate transmitter for each channel
  - PA technology MMIC GaAs pHEMT - Power is 23 dBm per channel
    - cost approx £800 each in volume
  - By 1996 transmitter powers of 1 Watt per channel could be available
  - Horn Antenna for each channel => 15 dB gain
  - Cost estimate: £33,000-£57,000 for transmitter station

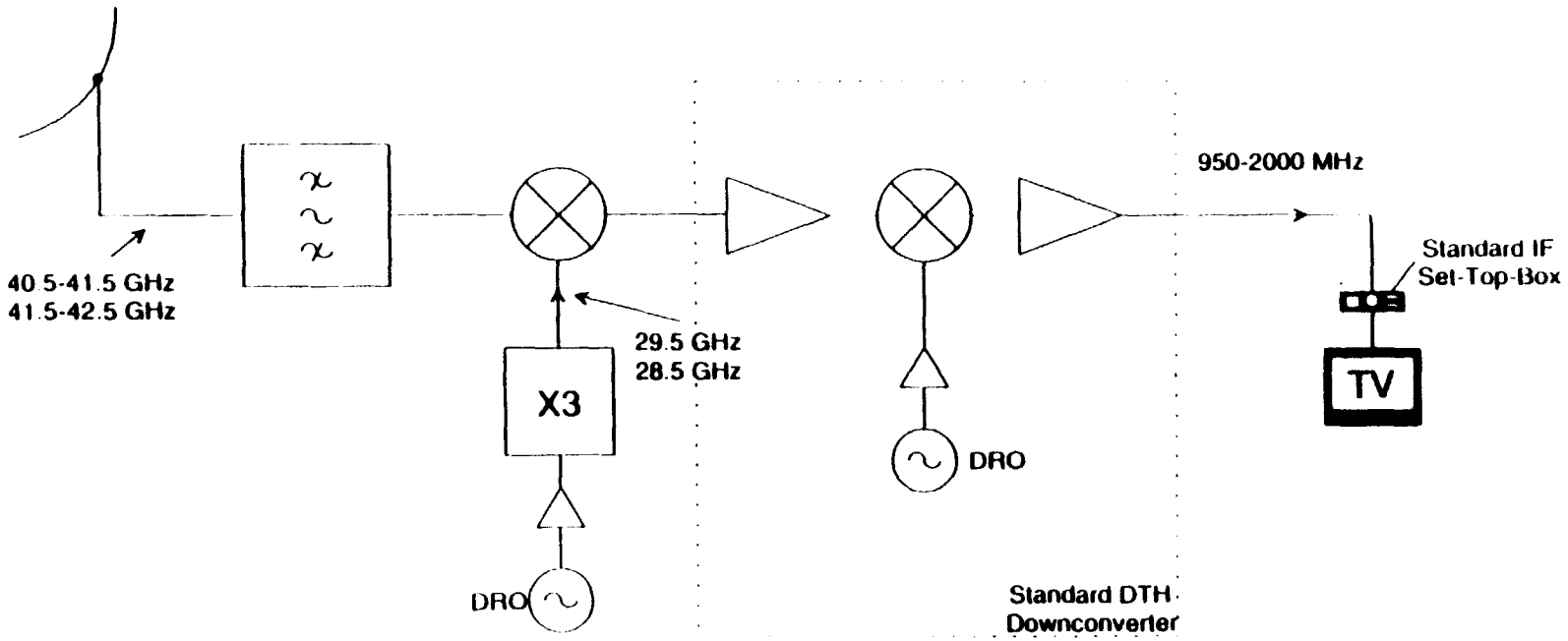
Philips Transmitter Unit



Current MVDS Equipment

- Receiver Unit
  - Based on commercially available satellite DTH Downconverter
  - Extra downconversion stage from 40 GHz to 12 GHz (1st IF)
  - 2nd IF: 950 - 2000 MHz
  - 2nd IF fed into standard satellite DTH receiver set-top box
  - Rx Antenna
    - Horn Antenna
    - Small size - low cost
    - High Gain (32 dBi) so eliminates need for LNA in Receiver
  - estimated cost for 40 GHz MVDS receiver (excluding indoor set-top box) is £65 - £130

Philips Receiver Unit




MVDS 8+1 TRANSMITTER

Current MVDS Equipment

- Other Hardware Providers
  - GEC Marconi, UK
    - Working on 40 GHz MVDS demo, available June 1995
    - On target for production late 1995
  - 40 GHz components available from a number of suppliers:
    - Farran Technology, Ireland
    - Thompson CSF
    - RACAL

SUMMARY

- Philips are developing 40 GHz equipment which will be available in production by August 1995
- Eurobell intend to use Philips equipment in their local delivery franchise which will begin in 1996
- Digital MVDS is currently being devloped which can provide approx 300 channels in 1 GHz
  - Philips plan to have this 40 GHz digital equipment in production by end of 1996

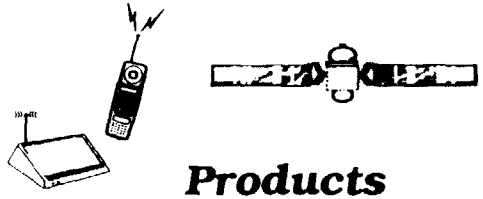
HUGHES

SPACEWAY™

Providing Affordable Telecommunications Solutions

April 1995

Hughes Is a Global Wireless Telecommunications Provider

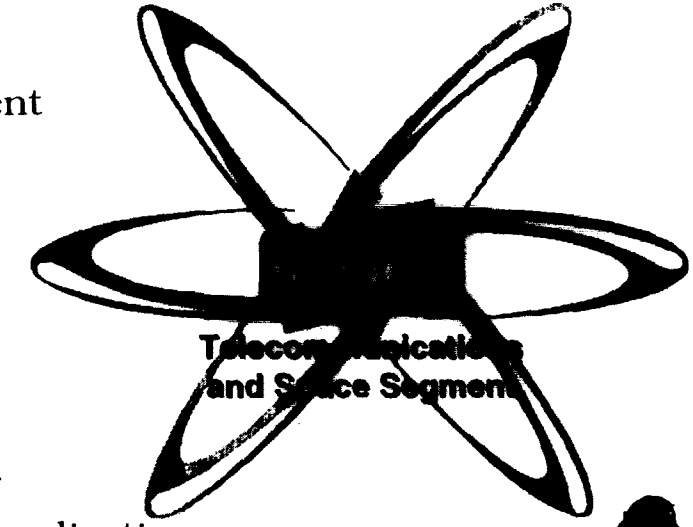


Products

- Satellites
- Digital cellular equipment
- VSAT networks

Markets

- Telecommunications equipment in use in 45 countries



Services

- Satellite system operator
- Leasing for government applications
- Business systems integrator
- Direct-to-home television entertainment
- Mobile satellite service provider

Technologies

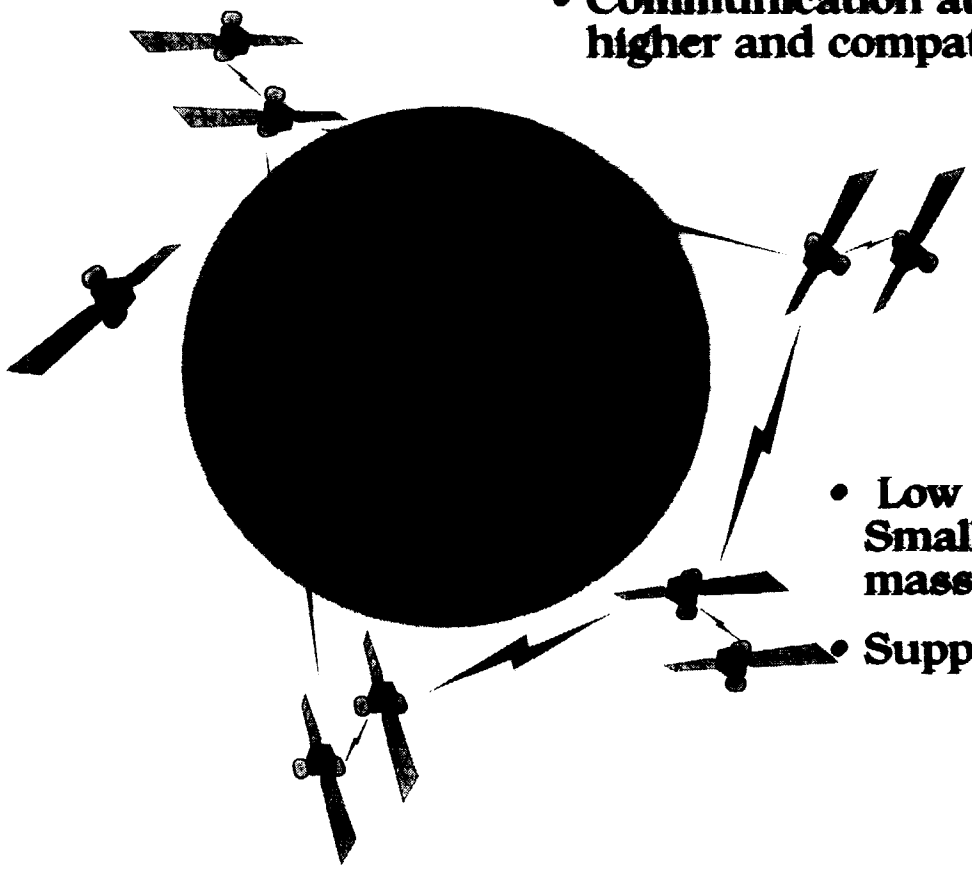
- Digital direct broadcast television
- Space-based digital processing
- ETDMA
- Fixed Wireless
- Local area networks and internetworking

Hughes is a world leader in many of the products and services we provide.

SPACEWAY™ Overview

HUGHES
COMMUNICATIONS
A unit of GM Hughes Electronics

- Provides worldwide "bandwidth on demand"
  - Interactive, digital, low cost, Ka-band communications services: voice, data, images and video
- Communication at rates from 16Kbps to 1544 Kbps and higher and compatible with terrestrial services



- Multiple Satellite constellation serving four interconnected regions:

  North America, Asia Pacific, Central/South America, and Europe/Africa

- Service initiates 1998: global coverage in place by 2000
- Low cost (<$1,000), easily installable Ultra Small Aperture Terminals (26") accessible to mass markets
- Supports over 5 to 10 million subscribers

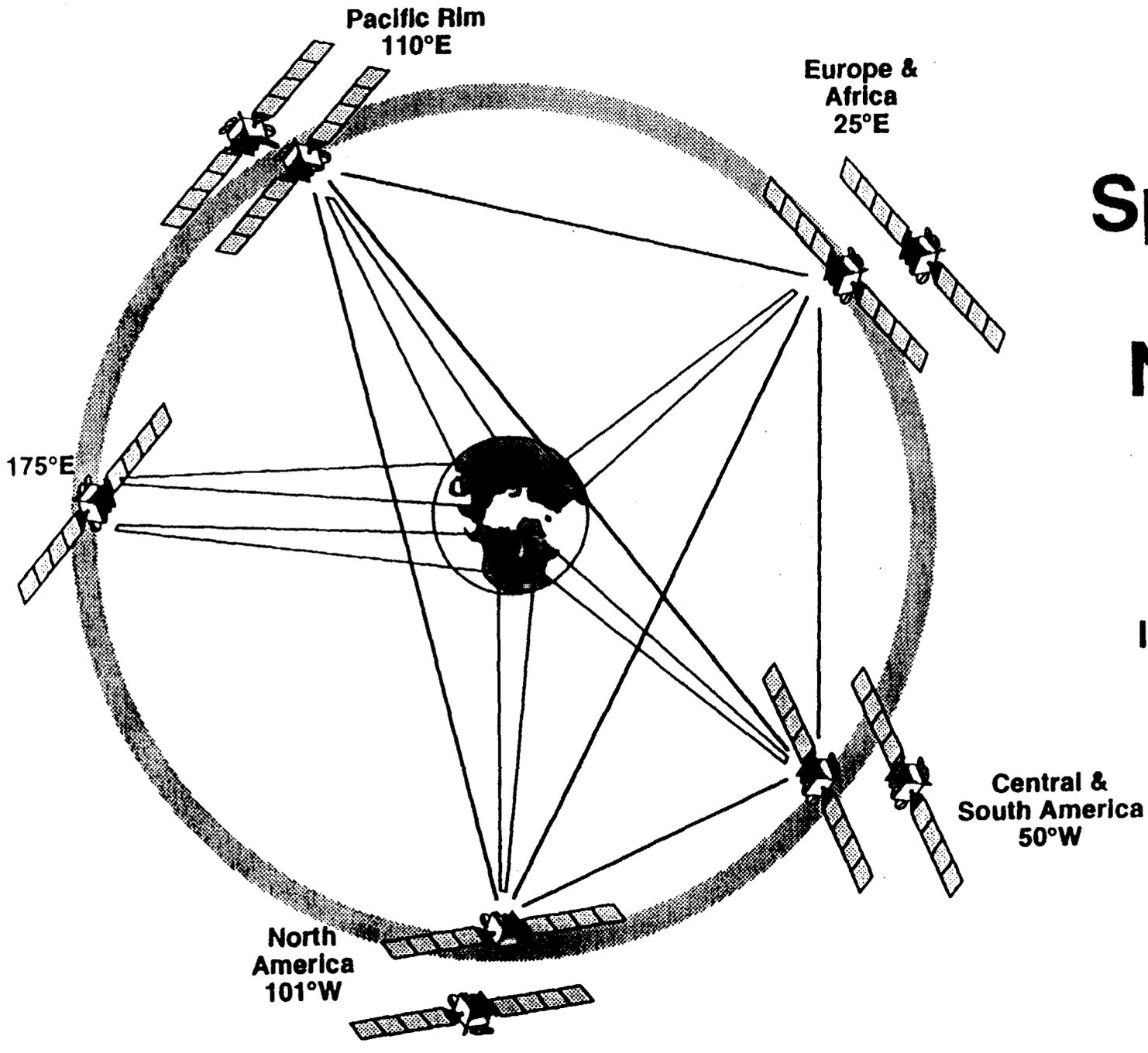


Figure 1.

Spaceway Global Network

Phase 1

Orbital Locations

Initial Operating Capability

940417-093

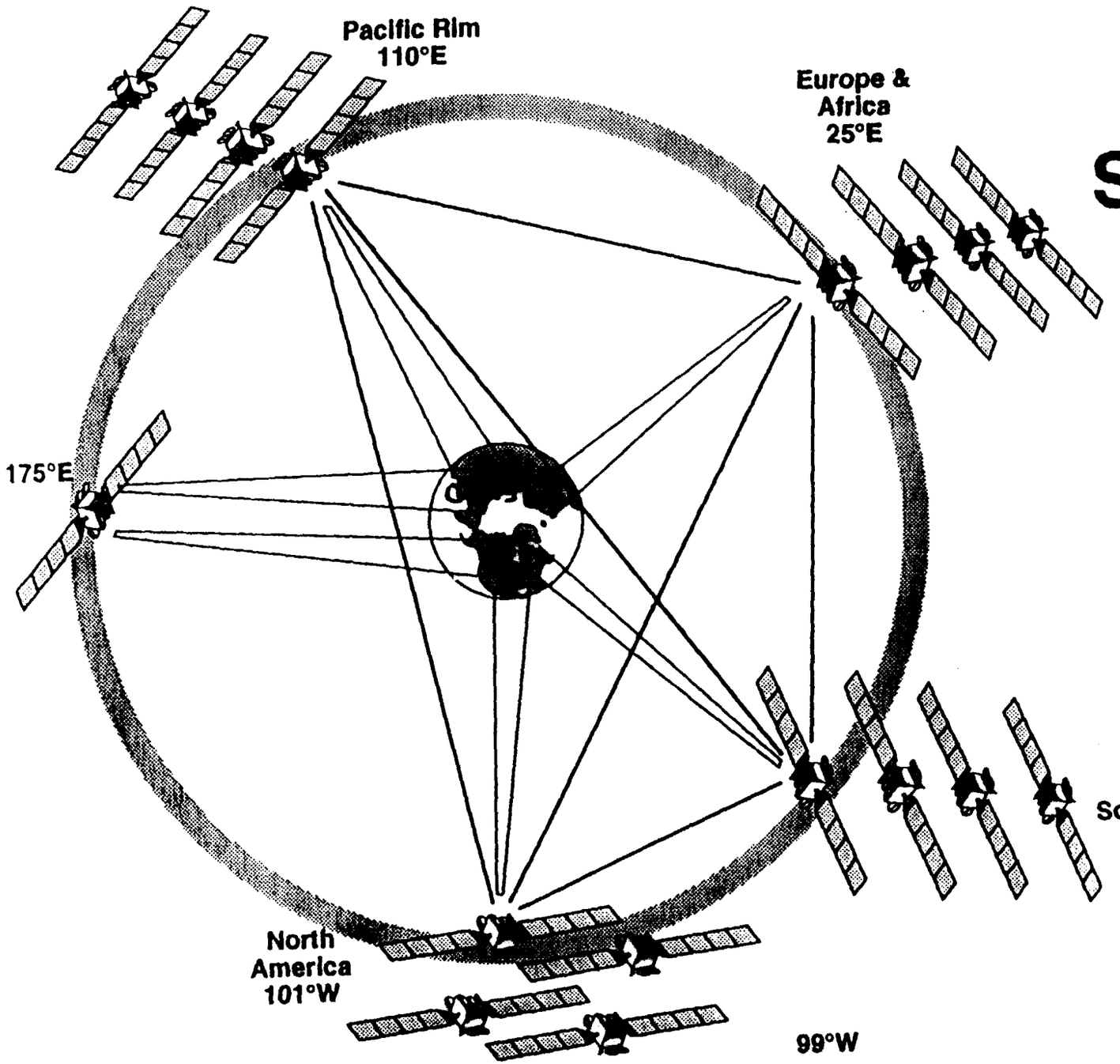


Figure 1A.

Spaceway Global Network

Phase 2

Orbital Locations

Full Operating Capability

940417-093A

SPACEWAY™ IS A UNIQUE SATELLITE SYSTEM

HUGHES COMMUNICATIONS

19 APRIL 1995

MARKET BENEFIT

- **AFFORDABLE SERVICE**
  - LOW COST
  - PAY FOR WHAT YOU USE
- **WIDE RANGE OF APPLICATIONS**
  - TELEPHONY
  - POINT OF SALE
  - VIDEO CONFERENCING
  - REGIONAL DTH
- **FULL CONNECTIVITY**
  - POINT-TO-POINT
  - LAN
  - MULTICAST / BROADCAST

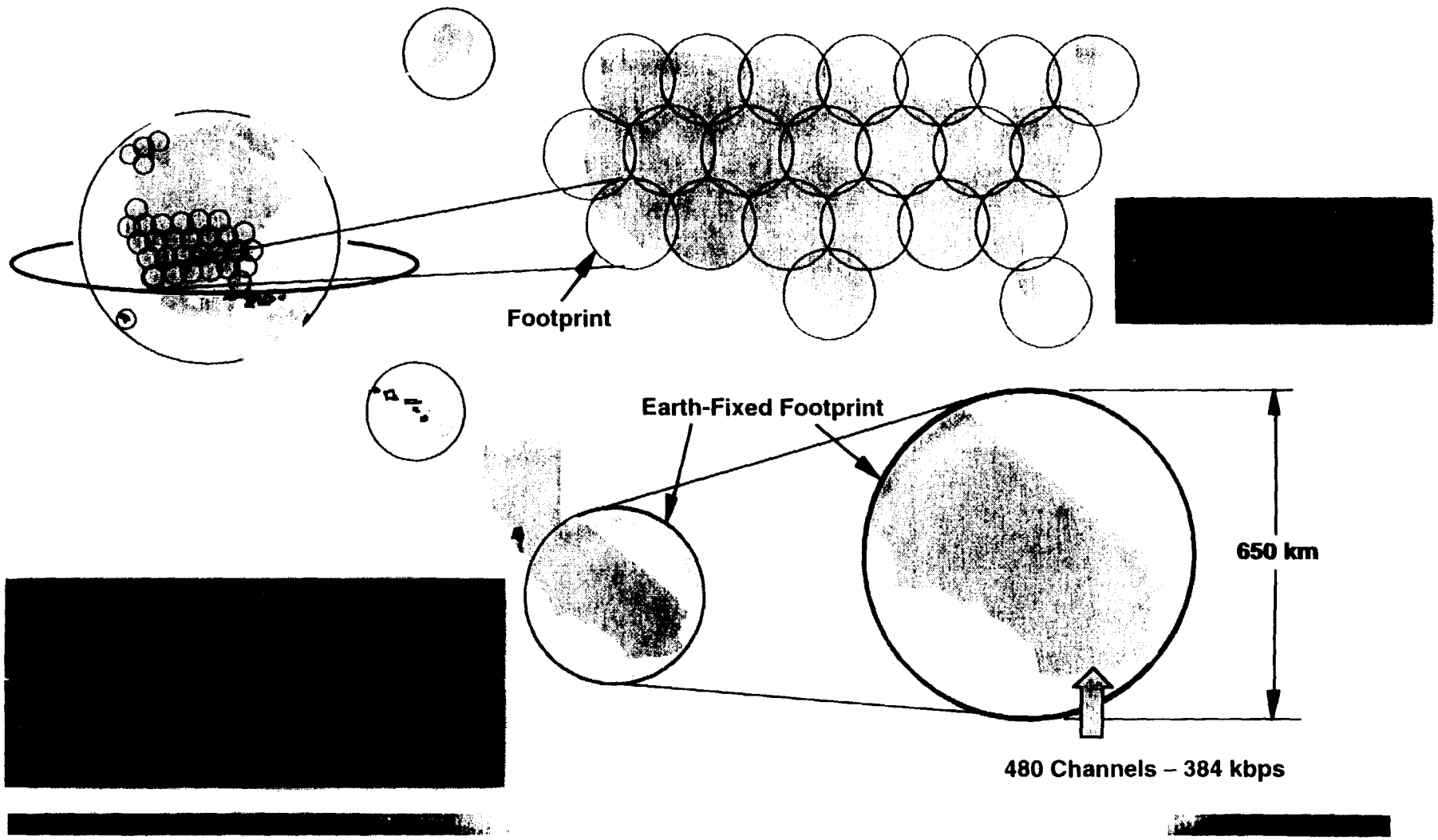
SPACEWAY™ ARCHITECTURE

- **SPOT BEAM ARCHITECTURE**
  - LARGE SYSTEM CAPACITY
  - TWELVEFOLD FREQUENCY REUSE
  - SMALL TERMINALS / NEXT GEN VSAT
- **BANDWIDTH ON DEMAND**
  - FAST PACKET SWITCHING
- **WIDE RANGE OF DATA RATES**
  - 16 KBPS TO 1.5 MBPS (20 MBPS)
  - CONSTANT BIT RATE / BURSTY SERVICES
  - 92 MBPS DOWN LINK
- **ON BOARD ROUTING**
  - SINGLE HOP BEAM-TO-BEAM
  - FULL MESH CONNECTIVITY
  - ATM COMPATIBLE

SPACEWAY™

Spot Beam Technology Permits High Frequency Reuse and High System Capacity

HUGHES
COMMUNICATIONS



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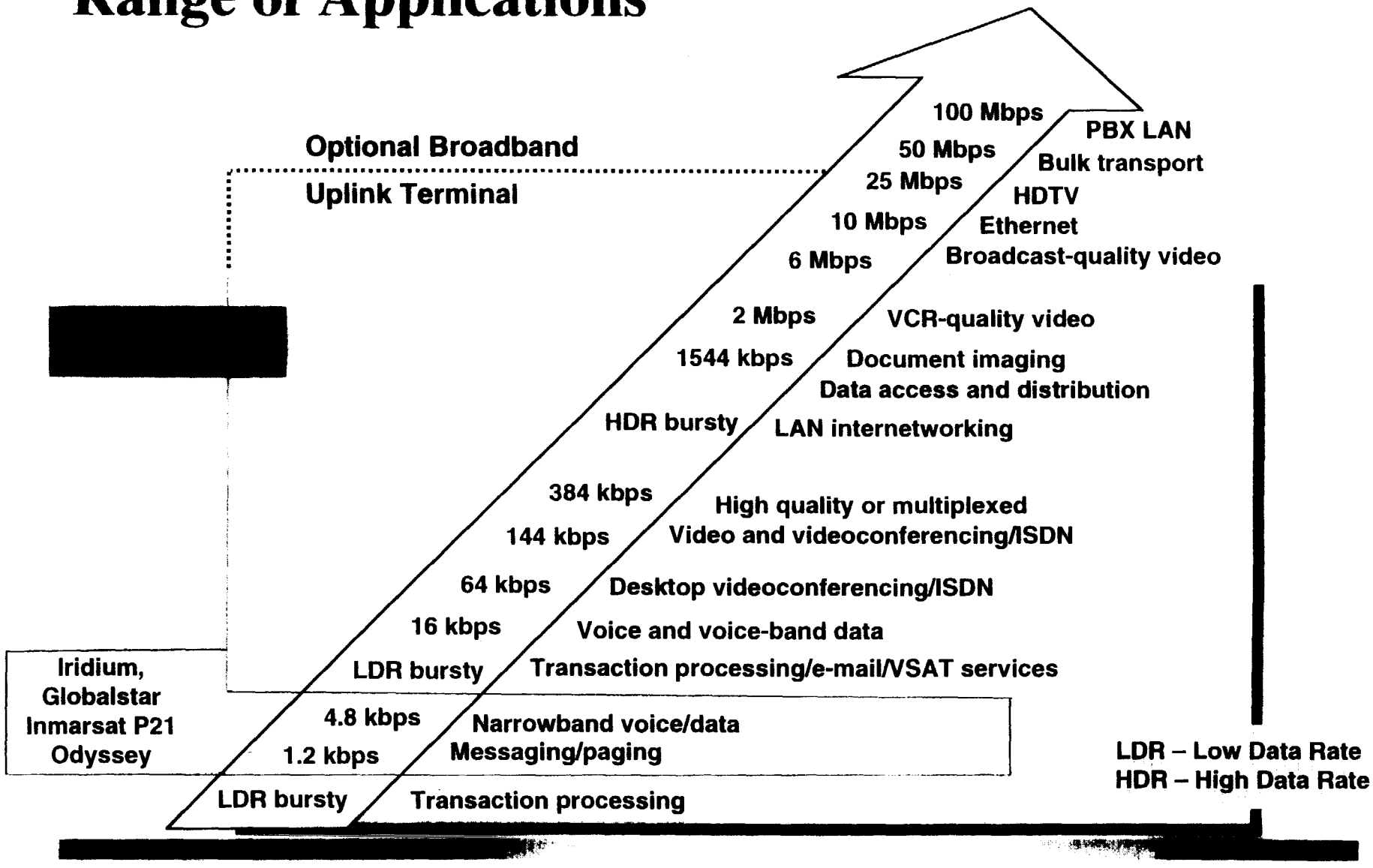
SPACEWAY™ Enables a Wide Range of Applications

HUGHES COMMUNICATIONS



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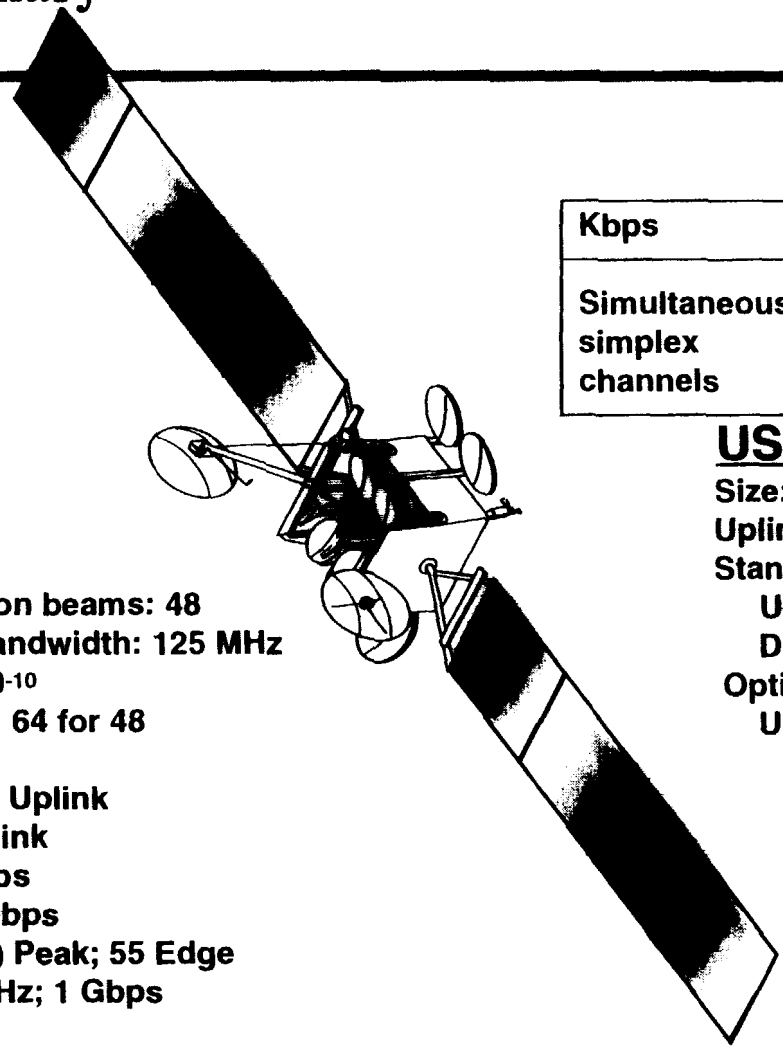
SPACEWAY™
Performance Summary



Capacity per satellite

Kbps	16	128	384	1,544	2,048
Simultaneous simplex channels	230,400	34,560	11,520	2,880	2,304

Satellite

Type: HS601
Lifetime: 15 yrs
Dry weight: 3,785 lbs
Eclipse capacity: 100%
Bandwidth: 500 MHz
Number of communication beams: 48
Communication beam bandwidth: 125 MHz
BER performance: 1×10^{-10}
Transmitter redundancy: 64 for 48
Modulation: QPSK
Data stream: FDM/TDMA Uplink
TDM Downlink
Data throughput: 4.6 Gbps
Downlink data rate: 92 Mbps
Downlink EIRP: 60 (dBw) Peak; 55 Edge
Inter satellite links: 60 GHz; 1 Gbps

USAT

Size: 66 cm to 2 m
Uplink power: 0.1w to 2.0 w
Standard Terminal:
Uplink data rates: 16 kbkps to 1.544 Mbps
Downlink data rates: 16 kbps to 92 Mbps
Optional Uplink Terminal:
Uplink data rates: Up to 6 Mbps

SPACEWAY™ Services are Market-Focused

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Infrastructure Enhancment

- **Rapid build-out** → **– Available 1998**
- **High quality** → **– Digital transmission quality**
  - **– Significantly superior to mobile alternatives**
  - **– Echo cancellation**
  - **– 16 Kbps toll quality voice**
- **Ease-of-use** → **– Seamless terrestrial interconnectivity**
  - **– Local, long distance, international connections**
- **Lower cost** → **– High system capacity**
  - **– Regional implementation**
  - **– Mass produced USATs**
  - **– Service charges competitive with terrestrial wireline**

Interactive Multimedia

- **Rapid deployment** → **– Simple rapid installation: "One stop shop"**
- **Bandwidth-on-demand** → **– Versatile service offerings; usage based pricing**
- **High data rates**
  - **– Up to E1 (2.048 Mbit/sec) 20 Mbps with optional uplink terminal**
- **Compatible with latest terrestrial technology** → **– ATM**
  - **– Frame Relay**
  - **– ISDN**
  - **– Videoconferencing**
- **High quality** → **– Greater than 99.5% availability**
  - **– BER comparable with terrestrial ATM (fiber)**
- **Lower cost** → **– Lower priced equipment and service than terrestrial alternatives**

SPACEWAY™ flexibility allows the system to evolve as markets develop, shifting seamlessly between voice and wideband telecommunications.

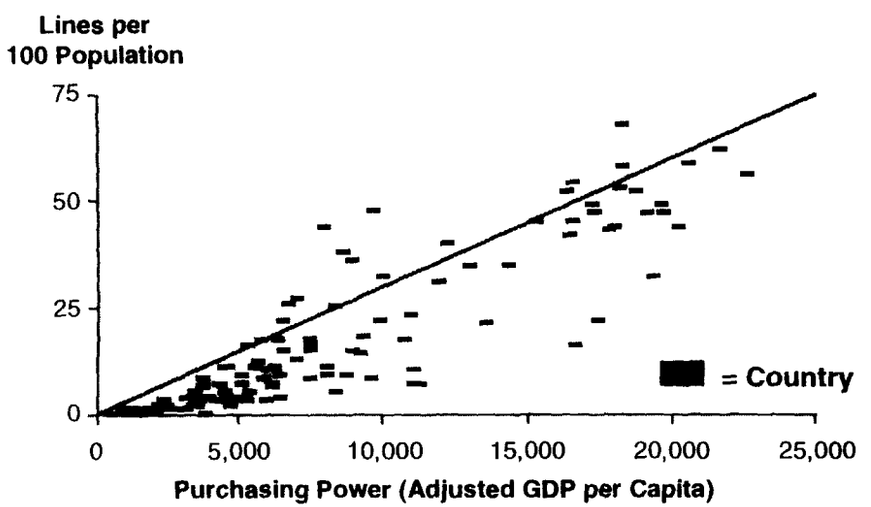
SPACEWAY™ Provides High Quality Telephony Service

Cost Effective	**Competitive with terrestrial alternatives in many areas.**
	Affordable service to underserved.
Modest Delay	**Single hop delay less than 320 ms**
No Echo	**All digital technology incorporates echo cancellation**
High Quality	**16 Kbps ensures much better voice quality than mobile alternatives**
Affordable, High Capacity	**SPACEWAY™ system capacity ensures more affordable prices than mobile alternatives**

HUGHES
COMMUNICATIONS

...Fulfilling the Needs of the Underserved

Telephony Services

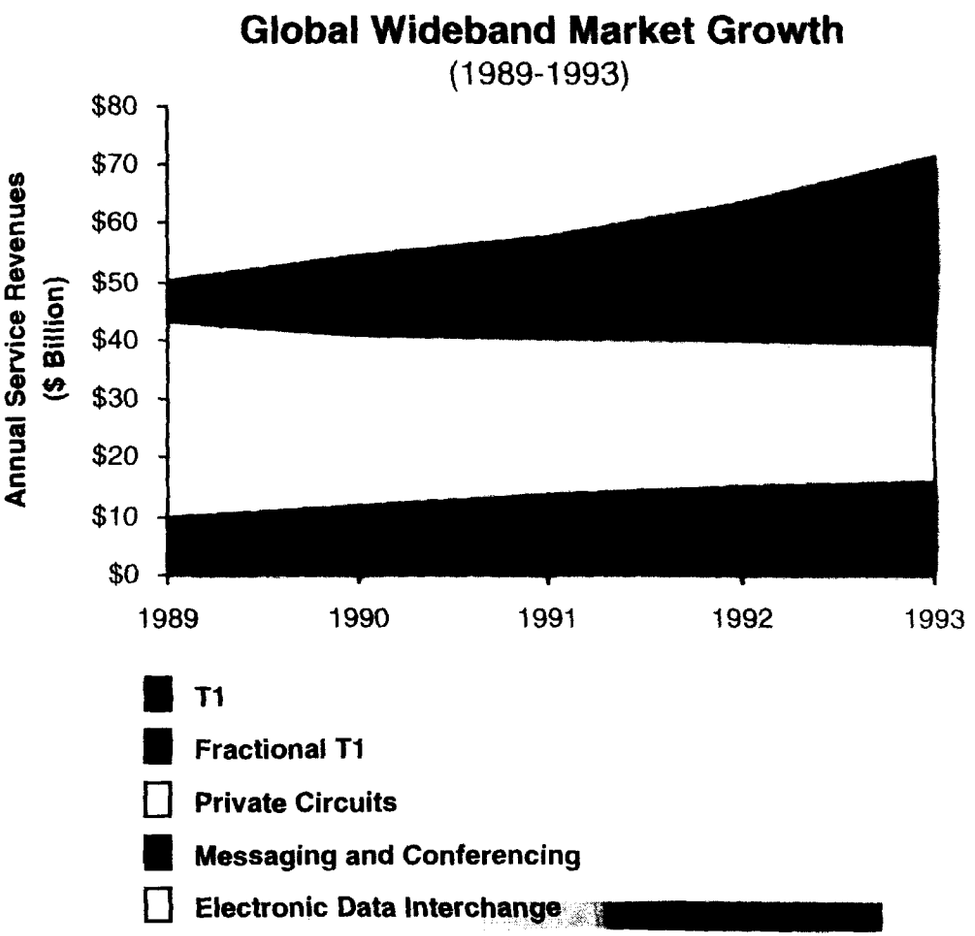


- 90% of the 600,000 villages in India have no form of telephone service.

- "To better serve their 1.2 billion population and exponential economic growth, they [China] are annually adding approximately 10 million new main lines, 500,000 new mobile subscribers, 5 million new paging subscribers...."

  –Telecommunications Industry Association

Wideband Services



INCREASED TRANSMISSION RATE
SPACEWAY™ OFFERS HIGH DATA RATES

HUGHES COMMUNICATIONS

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DOCUMENT	INFORMATION	PHONE LINE (9.6 kbps)	SPACEWAY™ (384 kbps)	SPACEWAY™ (1.5 Mbps)
PHOTO	1 MBIT	1.7 MIN	2.6 SEC	0.7 SEC
CAD/CAM	2 MBITS	3.4 MIN	5.2 SEC	1.4 SEC
CT SCAN	5.2 MBITS	9.0 MIN	13.5 SEC	3.4 SEC
X RAY	12 MBITS	21.0 MIN	31.3 SEC	7.8 SEC

SPACEWAY™ High Capacity for Each Region

Each satellite provides:

- **Reliable service throughout region**
- **Basic telephony/fax and wideband data for multimedia applications**
- **6 GHz effective bandwidth per satellite using polarization and spatial reuse**

North America

Asia-Pacific

Central & South America

Europe & Africa

SPACEWAY™ CAPACITY SUMMARY
SIMULTANEOUS SIMPLEX CIRCUITS

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	16 kbps	128 kbps	384 kbps	1544 kbps
SINGLE FOOTPRINT	9,600	1,440	480	120
ONE SATELLITE	230,400	34,560	11,520	2,880
REGIONAL SYSTEM (4 SATELLITES)	921,600	138,240	46,080	11,520
WORLD WIDE SYSTEM (17 SATELLITES)	3,916,800	587,520	195,840	48,960

ROBUST MARKETS

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PRIMARY APPLICATIONS:

- INFRASTRUCTURE ENHANCEMENT
  - TELEPHONY
  - FAX / DATA
  - TRANSACTION PROCESSING (VSAT SERVICES)
- INTERACTIVE MULTIMEDIA
  - HIGH SPEED DATA TRANSFER (LAN INTER-NETWORKING)
  - VIDEO CONFERENCING (DESKTOP & GROUP)
  - DISTANCE LEARNING
  - TELE-IMAGING / TELEMEDICINE
  - TELECOMMUTING

SECONDARY APPLICATIONS

- BROADCAST QUALITY VIDEO (REGIONAL DTH, HDTV)
- HIGH SPEED DATA DISTRIBUTION (VIDEO)
- MULTICASTING / DATA CASTING
- IMMEDIATE INFRASTRUCTURE (EMERGENCY / RAPID DEPLOYMENT)

Markets and Applications

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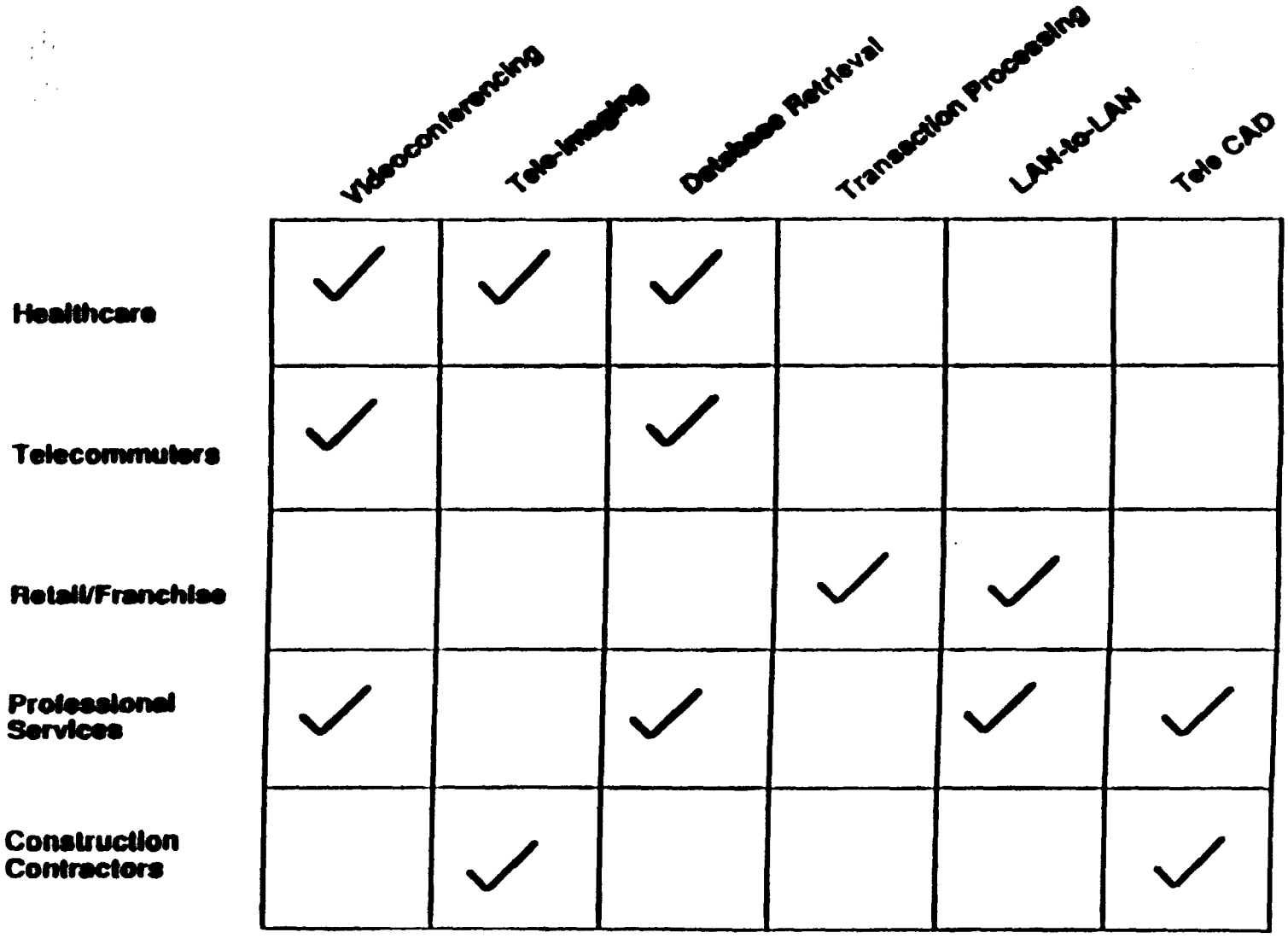

Markets and Applications
(Continued)

HUGHES

	Videoconferencing	Tele-imaging	Database Retrieval	Transaction Processing	LAN-to-LAN	Tele CAD
Agriculture	✓		✓			
Luxury Homes	✓		✓			
Banks	✓			✓	✓	
Manufacturing	✓					✓